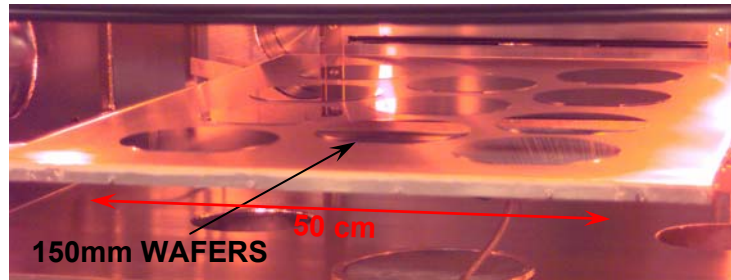
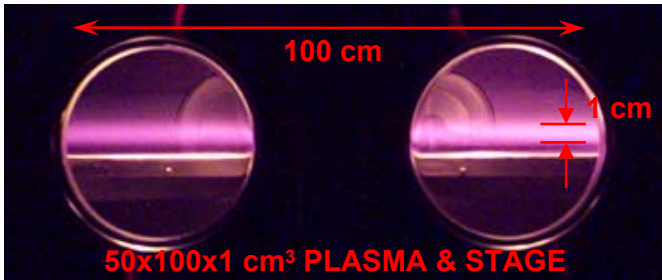


## TECHNOLOGY: LARGE AREA PLASMA PROCESING SYSTEM (LAPPS)



**DESCRIPTION:** The Naval Research Laboratory has developed a new type of plasma-based materials processing tool, utilizing electron beam (e-beam) generated plasmas. Unlike conventional plasma sources used in materials processing applications that apply external [electromagnetic] fields to breakdown gases, e-beam ionization produces a plasma that is independent of the chamber layout and readily scalable. Furthermore, since the plasma electrons are not being heated by external fields to sustain the plasma, the plasmas also possess low electron temperatures and internal fields, resulting in low ion temperatures.

### **Advantages/Features Include:**

- Inherently scalable system with large surface-to-volume ratio plasma
- Plasma production decoupled from stages, system geometry, and materials
- High density ( $10^{10}$ - $10^{12}$  cm<sup>-3</sup>) plasmas with low electron temperatures ( $\leq 0.5$  eV)
- Demonstrated unprecedented plasma process control
  - plasma density variable with e-beam current
  - ion and radical production directly proportional to gas composition
  - fluxes to surface variable with distance from e-beam ionization region
  - ion energies at surfaces  $< 5$  eV (can be raised with electrode biasing)

### **Demonstrated Applications Include:**

- Anisotropic etching of silicon and polymer (photoresist) materials
- High-rate surface hardening (nitriding) of metals
- Activation of polymeric materials from highly reactive plasma species
  - manipulate surface energies (create super/hydrophobic/philic surfaces)
  - increase bonding of thin metallic films
- Combine multiple plasma sources for advanced applications
  - sputter magnetron + LAPPS for broader range of reactive sputter deposition
  - LAPPS + LAPPS for double-sided processing of materials
- Low temperature deposition of silicon dioxide films

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